Ipsilateral Rockwood type IV acromioclavicular joint dislocation and midshaft clavicle fracture – a case report and review of the literature

Six word running title: Combined AC-joint dislocation and clavicle fracture

Jan C. van de Voort, MD, Department of Surgery, Alrijne Hospital, Leiderdorp, The Netherlands

Peter G. van Doesburg, MD, Department of Orthopaedic Surgery, Leiden University Medical Center, Leiden, The Netherlands

Michiel Leijnen, MD MSc, Department of Surgery, Alrijne Hospital, Leiderdorp, The Netherlands

Address for correspondence:
Jan C. van de Voort, MD, Department of Surgery, Alrijne ziekenhuis, Leiderdorp, The Netherlands
Email: jancvandevoort@gmail.com

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Abstract

The combination of ipsilateral acromioclavicular joint dislocation and midshaft clavicle fracture is rare. In the last 30 years only 29 cases have been reported in literature. We present a case of a 55-year-old woman with this combined injury pattern on the right side after a fall from a bicycle. She underwent open reduction and plate fixation of the clavicle fracture and repair of both the acromioclavicular ligaments and the coracoclavicular joint with semi-rigid surgical implants. Six months follow-up showed satisfactory results with full range of motion. Additionally, we provide an overview of the literature regarding this rare injury pattern with treatment options and functional outcomes.

Keywords:

Isolated midshaft clavicle fractures and acromioclavicular (AC) joint dislocations are common traumatic injuries of the shoulder. They account for approximately 45% of the traumatic shoulder injuries. However, an ipsilateral combination of these injuries is rare and few cases have been published in literature 1. If accompanying AC injury is not timely recognized and properly treated, it can lead to shoulder joint dysfunction, limited range of motion and chronic pain 19.
Combined AC joint dislocation and clavicle fracture

The clavicle serves as the bony connection between the arm and trunk, articulating laterally with the acromion (acromioclavicular joint) and medially with the sternum (sternoclavicular joint). The acromioclavicular joint is secured by the acromioclavicular and coracoclavicular ligaments. Both the acromioclavicular and coracoclavicular ligaments are part of the superior shoulder suspensory complex (SSSC). The SSSC concept was introduced by Goss et al in 1993, describing a soft-tissue and bony ring at the superior side of the shoulder maintaining a stable relationship between the upper extremity and the axial skeleton. A double disruption of the SSSC destabilizes the ring and probably needs surgery.

Treatment options of AC joint dislocations consist of conservative treatment, surgical semi-rigid implants like suture and (endo-)button and suspensory fixation options or rigid surgical options like Kirschner wires, hook plates and screw fixation. Clavicle fractures can be managed conservatively, surgically with plate and screw osteosynthesis or intramedullary nailing. No consensus or guidelines regarding the most optimal treatment of the aforementioned ipsilateral combination exists.

In this report we demonstrate a case of a midshaft clavicle fracture with ipsilateral AC joint dislocation including a detailed description of the surgical technique. The functional outcome was measured with the Dutch version of the Disabilities of the Arm, Shoulder and Hand questionnaire (DASH-DLV). Additionally, we provide an extensive overview of similar cases and their treatment with outcome results as found in literature.

**Keywords:** clavicle fracture; acromioclavicular-joint dislocation; tightrope; corkscrew
Case report

A 55-year-old, right hand dominant, female with no medical history presented on the emergency department with right shoulder pain after a low-speed bicycle versus car collision. She hit the car hood with her right shoulder. Physical examination showed swelling, a palpable midshaft fracture which was very painful, lateral clavicle tenderness and a negative piano key sign. The neurovascular status of the right arm was normal. Anteroposterior (AP) and AP cephalic 30 degrees angulation X-rays were performed. Imaging revealed a midshaft clavicle fracture with caudal angulation (Robinson type 2A2) and widening of the acromioclavicular joint (figure 1). Surgery was advised because of the ipsilateral combination of a midshaft clavicle fracture and AC joint injury.

Surgery was performed four days after trauma under general anesthesia in beach chair position. An anterior horizontal incision over the clavicle was made and the fracture site was identified and cleared. The lateral part of the clavicle was rotated backwards into the trapezius and when palpating, the coracoclavicular and acromioclavicular (trapezoid and conoid) ligaments were completely disrupted, making it a Rockwood classification type 4 acromioclavicular joint dislocation (figure 2a). The clavicle fracture was reduced and fixated with an anteriorly placed 7-hole Variax T10 plate (Stryker, Kalamazoo, MI, USA) with four cortical and two locking screws (figure 2b). After the clavicle was fixed anatomically, the acromioclavicular joint was evaluated and revealed persistent dislocation. The anatomical acromioclavicular relation was restored and temporarily fixated with a K-wire. Two 3.5 mm holes were drilled in the clavicle at the height of the medial and lateral side of the coracoid process with a distance of 18 mm to each other. An Arthrex TightRope (Arthrex, Naples, FL, USA) was passed through the medial drill hole, led underneath the coracoid process, passed through the lateral drill hole and tightened on the superior aspect of the clavicle. Two
Combined AC joint dislocation and clavicle fracture

Corkscrew anchors (Arthrex, Naples, FL, USA) were placed in the lateral end of the clavicle and sutured to the remaining ligament attached to the acromion to repair the ruptured AC ligament (figure 2c). Perioperative fluoroscopy confirmed anatomical reduction and good position of the osteosynthesis material (figure 3). The postoperative treatment consisted of sling immobilization for two weeks followed by functional active use guided by a physiotherapist, to what the pain permitted.

Follow-up eight weeks after surgery showed minimally impaired movements with abduction and forward flexion possible up to respectively 160 and 170 degrees and no vertical instability or tenderness over the AC joint. DASH-DLV score was 19.16. Six months post-surgery the patient was very content with the result (DASH-DLV score of 0) and showed excellent range of motion with 180 degrees forward flexion and abduction and internal rotation possible up to the eleventh thoracic vertebra.

Discussion

We reviewed 29 cases published over a timespan of 30 years (table 1). The injury pattern of ipsilateral midshaft clavicle fracture and AC joint dislocation has not been frequently described in literature, but it could be a more common combination than generally thought. In a retrospective study of a prospectively collected database in an urban level 1 trauma center with 383 patients with a diaphyseal clavicle fracture Ottomeyer et al found an incidence of 6.8% (n=26) overall. Incidence was equal between the surgically and conservatively treated groups. Superior plating of the clavicle was significantly associated with AC joint injury with no sure cause mentioned, suggesting the possibility of iatrogenic injury. In a retrospective German study this combination accounted for 0.09% (n=106) of 114.003 clavicle-related injuries without further specifying Rockwood subtypes.
Interestingly, Ottomeyer et al mentioned 96% of AC joint dislocations being a Rockwood type II or III, while in our review of case reports 45% (13/29) is a Rockwood type IV dislocation. 62% of the patients in their study were involved in motorized vehicle accidents, compared to 45% in the cases of our review. It could also be partially explained by the retrospective character of their study and a more thorough study of the X-rays than initially done. Moreover, most type II dislocations are treated conservatively and can give mild symptoms which, during the healing process, are maybe attributed to the clavicle fracture.

**Trauma mechanism**

The trauma mechanism causing ipsilateral AC dislocation and midshaft clavicle fracture is not totally clear. It must be a combination of a high energy trauma with a direct blow to and simultaneous rotation of the shoulder; tearing the AC and CC ligaments and forwarding the energy from lateral to medial hereby causing a spiral, oblique or wedge type fracture in most cases. In our review of 29 cases a fall from a (motorized) two-wheeler is the most common trauma mechanism (69%), indeed suggesting a combination of a direct blow to the shoulder and forward energy causing a rotation.

**Evaluation**

Acromioclavicular dislocations Rockwood classification type III, V and VI are relatively easy to diagnose with conventional fluoroscopy, while type II and IV can be more prone to be misclassified or missed. If AC dislocation is suspected an additional axillary radiograph should be made to determine anteroposterior dislocation in the sagittal plane as seen with a Rockwood type IV since this posterior displacement can be underestimated on an AP view. 
Combined AC joint dislocation and clavicle fracture

When this combination of injuries is missed and the patient is treated conservatively for their ‘solitary’ clavicle fracture, pain, loss of function and disability can occur as described by Mohammed et al. Because of chronic, symptomatic AC joint instability they performed a clavicle osteotomy and AC stabilization 25 months after occurrence of a midshaft clavicle fracture and missed Rockwood type IV AC joint dislocation. We therefore emphasize that thorough assessment of the AC joint and CC ligaments during physical and radiological examination and with a stress test during possible surgery (after clavicle fracture fixation) is warranted to avoid undertreating a possible floating or unstable clavicle and prevent possible functional impairment in the long-term.

Conservative treatment

Three cases of ipsilateral midshaft clavicle fracture and AC joint dislocation were treated fully conservative (10%) with another five cases only treating the AC joint dislocation surgically (17%). These eight cases involved all types of AC joint dislocations. Final functional outcome of these (partially) conservatively treated cases was satisfactory to patients and surgeons’ opinions. Notable is the case of a type VI AC joint dislocation as described by Juhn. The subacromial dislocation was initially missed and because of good range of motion and little pain after five days, conservative treatment was continued. Radiographs ten months postinjury showed some osteolysis of the distal clavicle, which could be seen as the natural counterpart of a distal clavicle resection in a chronic setting. Juhn et al emphasize that attention should be paid to the extent of inferior displacement, although mention that type VI dislocations will normally be surgically treated.

Surgical treatment
Combined AC joint dislocation and clavicle fracture

All 26 surgically treated patients had excellent clinical outcomes, no complications were mentioned. In two of 26 cases (7.7%, type II and type VI AC joint dislocation) only the clavicle fracture was fixated during surgery. In 24 of 26 surgically treated cases (92.3%) ligament injury was treated. In 8/24 cases (33.3%) both the AC and CC ligaments were addressed, in 9/24 cases (37.5%) respectively 7/24 cases (29.2%) it was the AC- or the CC-relation that was repaired or reconstructed.

Of the surgically treated patients, 8 (30.8%) underwent fixation of the clavicle with additional repair or reconstruction of both the AC- and CC-ligament in different ways. In five cases (19.2%) clavicle fixation and repair of only the AC-joint was done, while in 5 cases (19.2%) clavicle fixation with only addressing the CC-ligament was performed. Solitary AC-joint or CC- ligament reconstruction was done in respectively four (15.4%) and two (7.7%) cases (figure 4).

In 20/26 cases (76.9%) the clavicle fracture was fixated, which was accompanied with simultaneous AC- and CC reconstruction in eight cases (30.8%). In 6/26 cases (23.1%) only soft-tissue injury was addressed and the clavicle fracture left undisturbed. No differences in functional outcome or pain were seen between these groups.

Surgical implants

In eight cases (30.8%) hookplates were used which were removed after a period of time in 5 cases (63%). In six cases (23%) pins or wires were used for AC joint fixation with the material being removed in five cases (83.3%). In four cases coracoclavicular screws were used which were removed in three cases after the coracoclavicular ligament was healed (75%). Overall, in 13/18 cases (72.2%) the rigid fixation material used for AC/CC joint
stabilization was removed in a second surgery because of complaints or limited range of motion. No re-operations were necessary when a semi-rigid fixation system was primarily used.

Fixation of the AC joint dislocation seems necessary to normalize coracoclavicular distance to allow healing of the ligaments and hereby restoring AC joint stability in the long-term. Surgical management of solitary type III AC dislocation remains controversial.

All cases had in common that a floating clavicle injury was recognized and that different, but well overthought and substantiated surgical techniques led to great functional outcomes regardless the treatment chosen. Review of the literature shows a preference for treating both the bony and soft tissue injury in this fracture-dislocation trauma to enable fast postoperative training and recovery and prevent stiffness of the joints.

Conclusion

An ipsilateral AC joint dislocation in combination with a midshaft clavicle fracture is a rare injury, although possibly more common than generally thought. If this injury pattern is timely recognized and treated, functional outcome is great, regardless of the treatment chosen. When midshaft clavicle fracture is suspected or confirmed, it is important to assess the possibility of acromioclavicular joint dislocation and a complete clinical and radiological work-up must be performed. No consensus about the most optimal treatment exists with many different options being mentioned. It seems there is a preference for surgically treating both the bony and ligament components simultaneously in case there is at least a Rockwood type 3 or higher AC joint dislocation.
References


**Dedicated legend page**

**figure 1** AP and AP cephalic angulation view X-rays of the right shoulder show ipsilateral midshaft clavicle fracture with caudal angulation and widening of the acromioclavicular joint.

**figure 2** Perioperatively made photos clearly show the midshaft clavicle fracture (a), the acromioclavicular joint dislocation after plate fixation (b) and the used combination of rigid and flexible fixation systems (c).

**figure 3** Postoperative imaging shows anatomical reduction of the clavicle fracture and AC-joint dislocation and good position of the osteosynthesis material.

**figure 4** Pie chart graphic showing the percentages of different surgical treatment options.

**Table 1** Overview of cases with Rockwood and Robinson classification, trauma mechanism, type of treatment and final outcome.
<table>
<thead>
<tr>
<th>AC joint dislocation</th>
<th>Clavicle fracture</th>
<th>Gender, age and dominance (M/F, years, right/left)</th>
<th>Follow up time (months)</th>
<th>Outcome</th>
<th>Additional information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rockwood classification</td>
<td>Robinson classification</td>
<td>Fall from horse</td>
<td>Conservative</td>
<td>12</td>
<td>Normal function + FROM No pain</td>
</tr>
<tr>
<td>Type 2</td>
<td>NA</td>
<td>F, 33, NA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2A2, left</td>
<td>M, 38, NA</td>
<td>Fall from motorcycle</td>
<td>Knowles pin</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>2B1, left</td>
<td>M, 34, right</td>
<td>Fall from bicycle</td>
<td>Conservative: sling 5 weeks</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>2B1, right</td>
<td>M, 34, NA</td>
<td>Fall from bicycle</td>
<td>Hook plate + anterior plate CC sling of prolene mesh + Mitek anchors</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>2B2, left</td>
<td>M, 40, NA</td>
<td>Fall from motorcycle</td>
<td>Medial plate + lateral hook plate</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>2B1, left</td>
<td>M, 40, NA</td>
<td>Motor vehicle accident</td>
<td>Superior clavicle plate 2 coracoclavicular bone screws</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>2B1, left</td>
<td>M, 50, NA</td>
<td>Motor vehicle accident</td>
<td>Superior clavicle plate Hook plate</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>2B1, left</td>
<td>M, 65, NA</td>
<td>Motor vehicle accident</td>
<td>Anterosuperior clavicle plate Restoring CC ligament AC joint fixation with 2 K-wires + tension band wiring</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>2B1, left</td>
<td>F, 42, left</td>
<td>Motor vehicle accident</td>
<td>Hook plate Superior clavicle plate</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Type 4</td>
<td>NA</td>
<td>Fall from bicycle</td>
<td>Clavicle fracture conservative Carpectoclavicular bone screw</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>NA</td>
<td>M, 36, NA</td>
<td>Fall from bicycle</td>
<td>Clavicle fracture conservative Carpectoclavicular bone screw</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>NA</td>
<td>M, 23, NA</td>
<td>Motor vehicle accident</td>
<td>Clavicle fracture conservative Carpectoclavicular bone screw</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>NA</td>
<td>F, 19, NA</td>
<td>Fall from horse</td>
<td>Clavicle fracture conservative AC joint fixation with 2 Steinmann pins</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>2B1, right</td>
<td>F, 46, right</td>
<td>Fall from horse</td>
<td>Clavicle plate AC + CC ligament reconstruction with semitendinosus allograft</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>2A2, right</td>
<td>M, 32, NA</td>
<td>Fall from bicycle</td>
<td>Clavicle fracture conservative AC joint fixation with 2 K-wires Restoring AC ligament</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>2B1, left</td>
<td>M, 41, NA</td>
<td>Fall from bicycle</td>
<td>Anatomical clavicle plate Restoring AC + CC ligaments AC joint stabilisation with coracoid anchors</td>
<td>30</td>
</tr>
</tbody>
</table>
| Type | 2B1, left | M, 45, right | Fall from bicycle | Superior clavicle plate  
Coracoclavicular Endo-button technique | 5 | Normal function  
DASH 11.7 | - | Kakwani, 2011 30 |
|------|-----------|-------------|------------------|--------------------------------|----|----------------|-----|----------------|
|      | 2B1, left | M, 29, NA   | Fall from bicycle | Superior clavicle plate  
Coracoclavicular Endo-button technique | 12 | FROM Subjectively satisfactory | - | Eraghi, 2020 31 |
|      | 2B1, left | M, 36, amputated right side | Motor vehicle accident | Clavicle plate + hook plate | 6 | Normal function + near normal ROM  
Painless  
DASH 30 | Forequarter amputation other side  
Hookplate removed after 6 months | Wijdicks, 2012 26 |
|      | 2B1, right | M, 19, right | Motor vehicle accident | Superior clavicle plate  
5 mm resection of lateral clavicle  
Coracoclavicular bone screw through plate | 12 | Normal function + FROM Intermittent pain | CC screw removed after 3 months | Tidwell, 2014 25 |
|      | 2B1, NA | NA | NA | Clavicle plate  
Clavicle hook plate | 36 | Normal function + ROM  
No pain | Hook plate removed after 12 months | Woolf, 2013 28 |
|      | 2A1, left | M, 21, right | Fall from motorcycle | Lateral clavicle plate  
Arthroscopy: coracoclavicular dog bone buttoning | 13 | Pre-injury level  
Constant-Murley score 88 | Contralateral humerus shaft fracture | Madli, 2015 24 |
|      | 2B1, right | M, 43, NA | Fall from height | Hook plate + superior plate  
Clavicle-coracoid sling of prolene mesh + Mitek anchors  
Suturing AC capsule | 6 | FROM Pain based on osteoarthritis:  
lateral clavicle reaction | Plates removed after 5 months | Schots, 2020 22 |
| Type 5 | 2B1, NA | F, 19, NA | Fall from horse | Clavicle fracture conservative  
AC joint fixation with 2 Steinmann pins | 36 | FROM Painless | Pins remove after 8 weeks | Lancourt, 1990 19 |
|      | 2B1, left | M, 38, NA | Non specified road accident | Superior clavicle plate  
Coracoclavicular Endo-button technique  
Suture AC capsule | 18 | FROM Painless | - | Psarakis, 2011 20 |
|      | 2B1, right | M, 65, NA | Fall from motorcycle | Anterocephal icoracoid plate  
Coracoclavicular double Endobutton technique  
AC joint fixation with K wire  
Restoring AC + CC ligaments and AC capsule | 6 | Excellent function and ROM  
Constant-Murley score 92 | Right hemopneumothorax | Gao, 2021 4 |
| Type 6 | 2A2, right | M, 19, NA | Fall from bicycle | Restoring AC ligament  
AC joint fixation with 2 Steinmann pins | 12 | FROM No pain | Pins removed after 7 weeks | Grossi, 2013 4 |
|      | 2A2, right | M, 21, NA | Ice hockey blow | Conservative | 10 | FROM No pain | AC joint dislocation initially missed | Juhn, 2002 11 |
|      | 2B1, right | F, 40, NA | Fall from stairs | Superior clavicle plate + iliac crest autograft at fracture site | 9 | FROM No pain | Surgery 10 weeks after trauma | Davies, 2014 25 |
Surgical treatment

- ORIF clavicle + AC + CC reconstruction: 19.2%
- ORIF clavicle + AC reconstruction: 19.2%
- ORIF clavicle + CC reconstruction: 15.4%
- Solitary AC reconstruction: 7.7%
- Solitary CC reconstruction: 7.7%
- Solitary ORIF clavicle fracture: 30.8%